Cumberland Plateau High Conservation Value Forests Study Objectives April, 2003

This project was completed with the World Wildlife Fund as our primary end user. Our goal was first to develop methodologies for identifying high conservation value forests on an ecoregion by ecoregion basis, using the Cumberland Plateau as an example. Second, we explored methods for delivering the results to managers for practical use. Deliverable products specified in the contract include: (1) a landform (enduring feature) data layer, (2) a core forest (forest conservation opportunity areas) by landform data layer, and (3) a prioritization of forest conservation opportunity areas (e.g. high conservation value forest patches). All products were delivered via CD in ArcView-compliant format, and selected products are posted via Arc Internet Map Server.

Study Area

The Cumberland Plateau ecological section is composed of four subsections as circumscribed by Keys and Carpenter (1995), and is within on of the 'threatened ecoregions' of North American as defined by the World Wildlife Fund (Ricketts et al. 1999). The following description of subsections comes from the data attached to the ArcView coverage provided by the USFS in Keys and Carpenter (1995).

The Rugged Eastern Hills (221Ha) consists of low and high mountains with an average elevation of 750 meters (500 m low, 1000 m high). The geology is primarily sandstone and shale-clast loamy colluvium of Holocene and Wisconsin age. The average annual temperature is 55 degrees, which falls within the Mesic Temperature class. The moisture class is Udic with an average annual precipitation of 46 inches (175 cm.). The dominant vegetation is Chestnut Oak-Oak (White-Southern Red-Black)-Hickory (Mockernut-Pignut) with some American Beech. Small and medium intermittent and perennial streams are common, while forestry, mining, and recreation are the major human uses.

The geologic and environmental characteristics of the Southwestern Escarpment (221Hc) are very close to those of the Rugged Eastern Hills. However, the landscape is mostly high hills with Chestnut Oak-Northern Red Oak-Hickory (Mockernut-Pignut-Shagbark) as the dominant vegetation. Perennial streams are common with a few medium rivers and forestry as the major human use.

Open low mountains make up most of the Sequatchie Valley (221Hd) with an average elevation of 200 meters (100 low, 300 high). Cherty clay solution residuim of a Quaternary and older Cenozoic age compose the major geology. There is also some sandy clay decomposition residium and some undifferentiated silty clay decomposition residium. The temperature class is considered Thermic and Mesic with an average annual temperature of 58 degrees. The average annual precipitation is 46 inches (175 cm.). The dominant vegetation is Southern Red Oak-White Oak(Post Oak)-Hickory (Pignut-Mockernut-Sand). The surface water consists of the Sequatchie River and it's tributaries. The major human use is agriculture.

The Low Hills Belt (221He) consists mostly of high hills with an average elevation of 650 meters (300 low, 1000 high). The geology is sandstone and shale-clast loamy colluvium of Holocene and Wisconsin age. The average annual temperature is 55 degrees, which falls within the Mesic Temperature class. The moisture class is Udic with an average annual precipitation of 46 inches (175 cm.). The dominant vegetation is White Oak-Northern Red Oak-Hickory (Shagbark-Pignut-

Mockernut) with some Chestnut Oak forest. There are many small rivers, and perennial streams are few to common. The major human use is agriculture.

Methods

Creation of Distance Grids for Roads and Forest Land Cover

Each 30-m pixel in a grid is assigned a value from zero to nine for distance into the interior of a forest land cover patch and distance away from a road (methods are detailed in Diamond et al. 2001). For example a zero is assigned if the pixel is not forest, a one for all cells at the edge of a forest, a two for forest cells farther toward the interior of the forest patch, and so on until a nine is assigned for forest pixels more than 1,477.7 meters into the interior of a forest patch. Hence, each larger number corresponds with a greater distance toward the interior of a forest patch. A cell value of one corresponds with all cells 0 to 30 meters from the edge of a forest, and a two is assigned to cells 30 to 75 meters from the edge. The interval between high and low values for each category is 1.5 times the distance between high and low for the category below it. The road distance grid is similar to land cover type distance grids, with zero representing roads and rights-of-way and values one through nine assigned to pixels farther and farther from a road. Interstate highways with limited access, coded A1 in the U.S. Census Bureau's 2000 TIGER road shape files (see data files athttp://www.geographynetwork.com/data/tiger2000/datainformation.html), were assigned zeros for three pixels that represent the road and right-of-way, whereas a zero was assigned to the single center line pixel only for all other roads.

Creation of Landform (Enduring Features) Coverage

We created a landform coverage by calculating neighborhood statistics from 30-meter digital elevation model input data. We grouped all 30-meter pixels into landform classes, or enduring features, based on analysis of slope and relief within a 1-square kilometer (564-meter radius) circular neighborhood. Slope was broken into two categories: more than 50% of the neighborhood on >8% slope or less than 50%. Relief was broken into seven categories; 15 meters or less, 15 to 30 meters, 30 to 90 meters, 90 to 150 meters, 150 to 300 meters, 300 to 900 meters, and greater than 900 meters. Hence, fourteen landform types are possible (2 slope categories X 7 relief categories).

"Gap Analysis"

We used the distance grids for roads and forest to identify forest conservation opportunity areas (see below), and intersected this coverage along with the landforms with a Public Areas Database (PAD) provided by the World Wildlife Fund. The PAD is coded as to protection status (1 – highest, 2 – moderate, 3 – low) using Gap Analysis methods (Jennings 2000). We evaluated the protection status of the forest conservation opportunity areas as well as the landforms of the Cumberland Plateau by calculating areas within protected lands versus within the whole subsection.

RESULTS

"Gap Analysis" for Forest Conservation Opportunity Areas (FCOAs) and Landforms

We intersect the forest land cover distance grid with the road distance grid to identify forest conservation opportunity areas (FCOAs). For this example, we select all land cover grid cells with a value of three or more for both the forest distance grid and the road distance grid. The result is a FCOA coverage that represents areas more than 75 meters into the interior of a forest patch and

away from any road. More conservative or more liberal versions of FCOAs can be viewed by re-setting the pixel selection threshold; for example, a threshold of six, six will identify FCOAs that are more than 395.6 meters from a road or a forest edge, rather than 75 meters.

Overall Summary of Protection Status

More than 72% of the Cumberland Plateau is outside of 'protected lands' as defined within the PAD provided by World Wildlife Fund. Further, FCOAs make up 1,164,579 acres, or 16.3% of the Cumberland Plateau section. Of these, 386,430 acres, or 33.2% have some protection. Landform types 23, 24, and 25 (Hills, Breaks, and Low Mountains) make up almost 86% of the Cumberland Plateau. These landforms, especially 24 and 25, are generally over-represented in managed areas relative to their abundance in the section. In contrast, landform type 13 (Irregular Plains), which makes up over 9% of the section, is generally under-represented on protected lands.

The overall conclusion is that few FCOAs are conserved, and that none of the important landform/FCOA combinations are adequately represented on protected areas. For example, the best-case scenario for protection of any landform type within any subsection is type 25 (Low Mountains) in the Rugged Eastern Hills subsection. This landform type makes up 53.6% of the subsection, and 32.6% occurs on protected areas. However, protected FCOAs of landform type 25 only make up 6.3 % of the subsection, and these are scattered in 400 polygons.

Because none of the landforms by FCOAs are adequately protected, we set 'protection priorities' simply by assigning larger FCOAs a higher value than smaller ones on a subsection-by-subsection basis (Figure 3). The largest 20% of the FCOAs within a subsection is assigned Priority 1, the next largest 20% Priority 2, and so on to Priority 5. The refinement of priorities might be accomplished by attaching other variables to the FCOA polygons, including rare species counts, the area of target land cover (community) types, total or target vertebrate diversity, or target land cover diversity. Although beyond the scope of the current grant agreement, we have employed these methods for analysis of forests in the Ozark Highlands, and delivered a PowerPoint slideshow that outlines the procedures to the World Wildlife Fund project manger, Nick Brown.

Subsection-by-Subsection Summaries of Protection Status of FCOAs, Landforms and FCOAs-by-Landform

Forty-two percent of the Rugged Eastern Hills subsection (221Ha) (748,410 acres) is in GAP category 3, but only 0.08% (1,333 acres) is in GAP category 2. No lands have full protection offered by GAP category 1. About 17.4% (306,005 acres) of the subsection are Forest Conservation Opportunity Areas, while 45.8% (140,132 acres) of those FCOAs are protected. Thus almost 8% of the subsection is in protected FCOAs, the highest value for any subsection within the Cumberland Plateau. Landform type 24 (Breaks) is under-represented relative to its abundance in the subsection, whereas type 25 (Low Mountains) is over-represented.

In the Southwestern Escarpment subsection (221Hc), GAP category 3 lands comprise 645,136 acres (21.1%), 117,257 acres are in GAP category 2 (3.8%), and 21,961 acres are in GAP category 1 (0.7%). FCOAs make up 19.3% of the subsection (221Hc). Of those, 28.4% (167,337 acres) are protected. Hence less than 5.5% of the subsection is in protected FCOAs. Landform type 13 (Irregular Plains) is under-represented within protected FCOAs relative to its abundance within the subsection, whereas landform type 24 (Breaks) is over-represented.

The Low Hills Belt subsection (221He) has 397,431 acres, or 19.1%, of it's area in GAP category 3, 20,801in GAP category 2 (1.0%), and 2,080 acres (0.1%) in GAP category 1. A total of 224,016 acres, or 10.8%, are FCOAs; of those, only one-third are protected, giving a total of only 3.5% of the subsection. The protection afforded individual landform types is likewise low, with less than 23% of the entire subsection protected at any level.

There are 249,998 acres in the Sequatchie Valley (221Hd) with 3.4% (8,394 acres) in GAP category 3 and no lands in categories 1 or 2. Hence the percent of lands protected within any GAP category is much lower than for any other subsection of the Cumberland Plateau. A total of 45,699 acres (18.3% of the subsection) are in FCOAs, but only 5,734 acres, or 12.5%, of those are protected. Hence, only 2.3% of the subsection is in protected FCOAs, and forest restoration may be needed to provide adequate protection of the biota of this ecoregion.

Data Delivery Via Arc Internet Map Server

We have posted selected results on Arc IMS at:

http://aa179.cr.usgs.gov/website/ncumb/viewer.htm

This site can be accessed by going to http://www.cerc.usgs.gov/morap and clicking on 'Projects' and then on 'Cumberland Plateau.' We also developed plug-ins to facilitate limited GIS functionality regarding the selected data layers. This latter version will almost certainly not be practical for use by forest managers because the access time is too slow. The more limited version may or may not prove useful for the same reason. Field testing should be done; our preliminary notion is that Arc IMS is not currently practical to prove of much use to on-the-ground managers at this time.

Final Note

All data layers have been delivered in ArcView GIS-compliant format via CD to the World Wildlife Fund project manager, Nick Brown, and these comprise the primary value from this project. We also produced a potential forest restoration data layer for the electronic delivery package.

Literature Cited

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